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(12) **United States Patent**
Reynolds et al.

(10) **Patent No.: US 9,383,333 B2**
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(54) **REPLACEABLE MULTISTRIP CARTRIDGE AND BIOSENSOR METER**

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(60) Provisional application No. 61/653,603, filed on May 31, 2012.

(51) **Int. Cl.**
G01N 27/327 (2006.01)
G01N 33/487 (2006.01)

(Continued)

(58) **Field of Classification Search**
CPC G01N 33/48757; G01N 33/48778; G01N 33/487; G01N 27/3272; G01N 27/3273; B65B 5/08; B01L 2300/0636; B01L 2300/082
See application file for complete search history.

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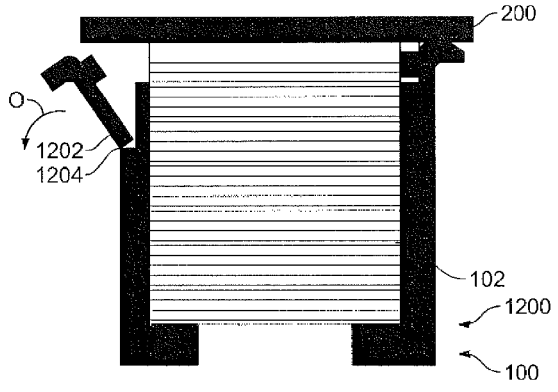
(74) *Attorney, Agent, or Firm* — Dugan & Dugan, PC

(57) **ABSTRACT**

A blood glucose monitor includes a can, a replaceable sensor cartridge that includes a frame, an upper spring disposed between the frame and the can, a case for housing the can and sealing the frame, a lower spring disposed between the can and the case, and a meter housing for sealing an upper portion of the frame. The can is capable of accepting the replaceable sensor cartridge. The frame of the removable cartridge has at least at least two walls defining a chamber for accepting a plurality of biosensors, and a bottom portion defining an opening and at least one sealing flange. The frame can further include a desiccant material capable of reducing humidity within the frame. The frame may be dimensioned such that an interference fit constrains the plurality of biosensors prior to inserting the frame within a blood glucose monitor.

12 Claims, 18 Drawing Sheets



(51) **Int. Cl.**
A61B 5/15 (2006.01)
A61B 5/145 (2006.01)

(52) **U.S. Cl.**
CPC *A61B5/14532* (2013.01); *A61B 5/150022* (2013.01); *A61B 5/150358* (2013.01); *A61B 2562/0295* (2013.01)

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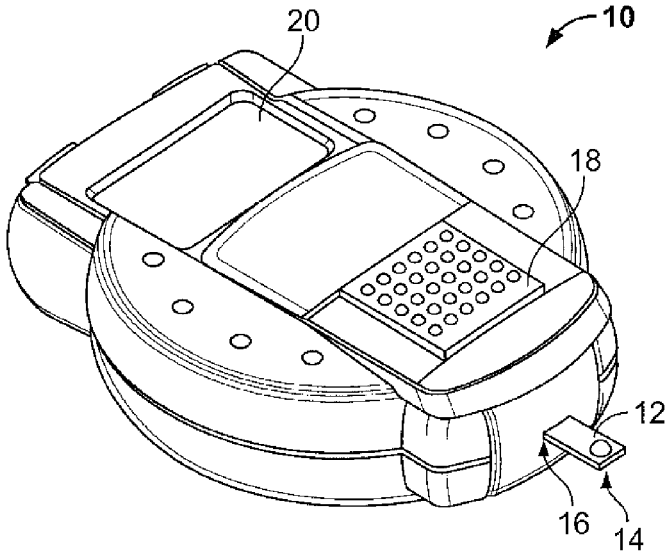


FIG. 1
(Prior Art)

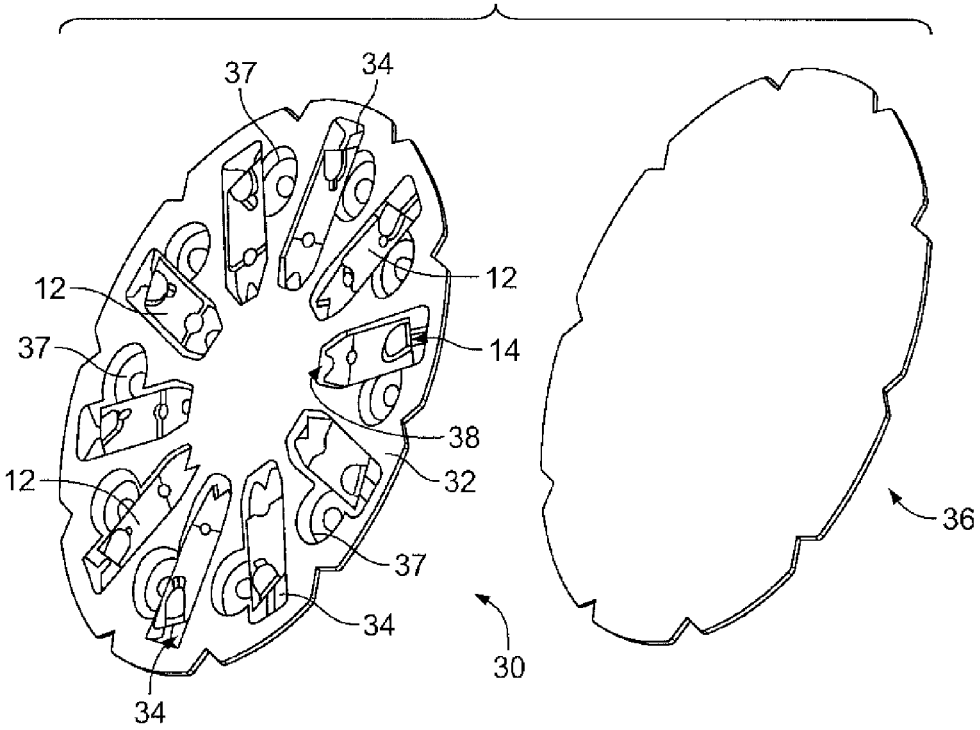


FIG. 2
(Prior Art)

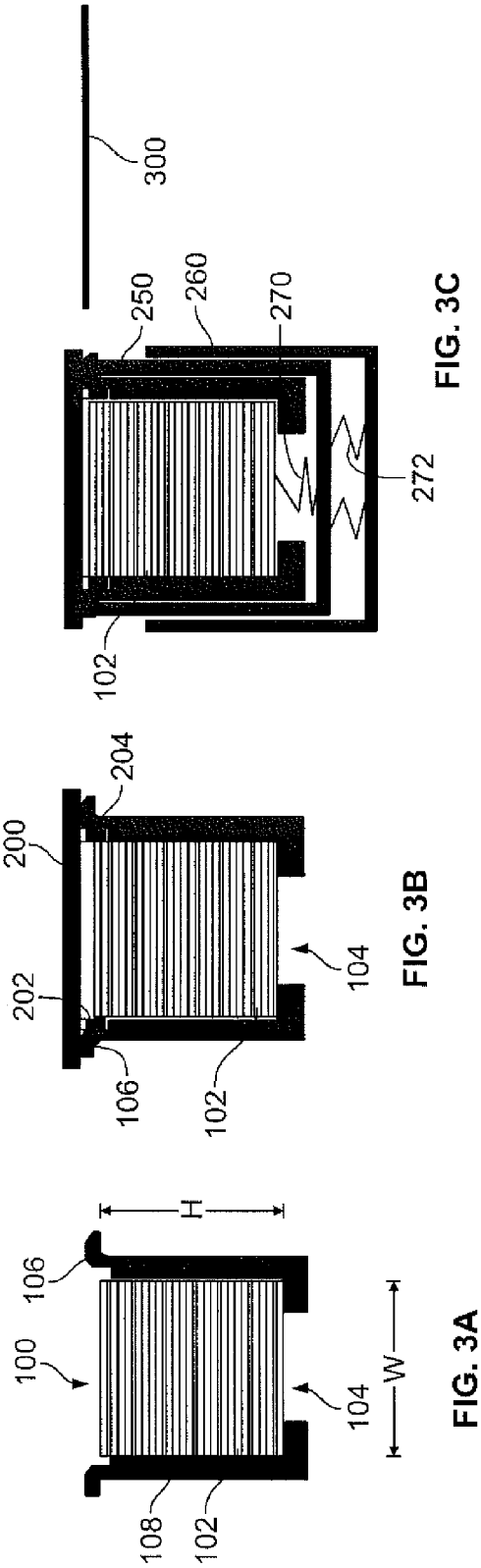


FIG. 3A

FIG. 3B

FIG. 3C

FIG. 3D

FIG. 3E

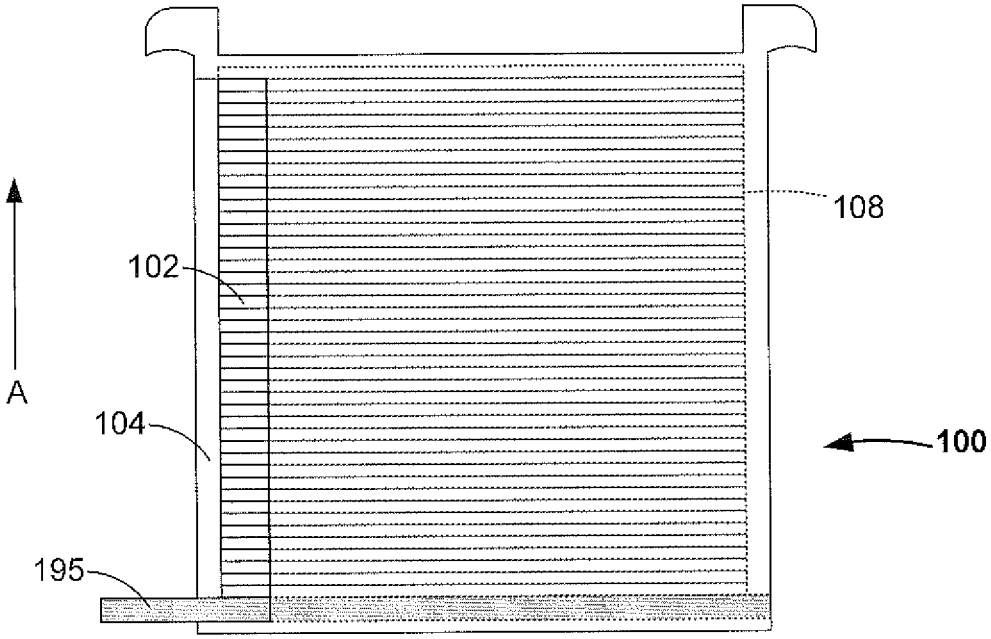


FIG. 3F

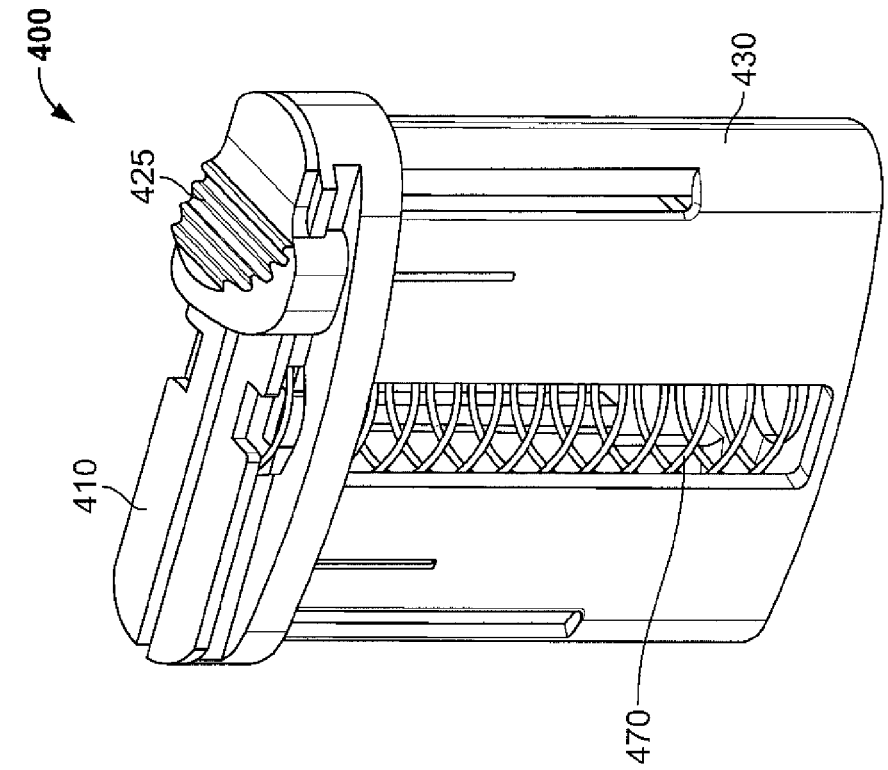


FIG. 4B

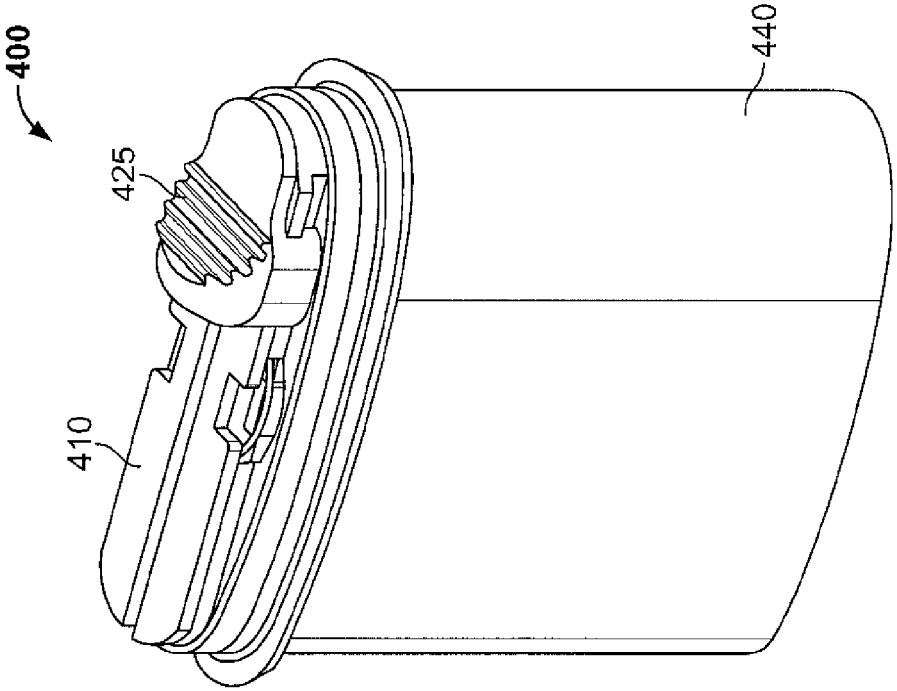


FIG. 4A

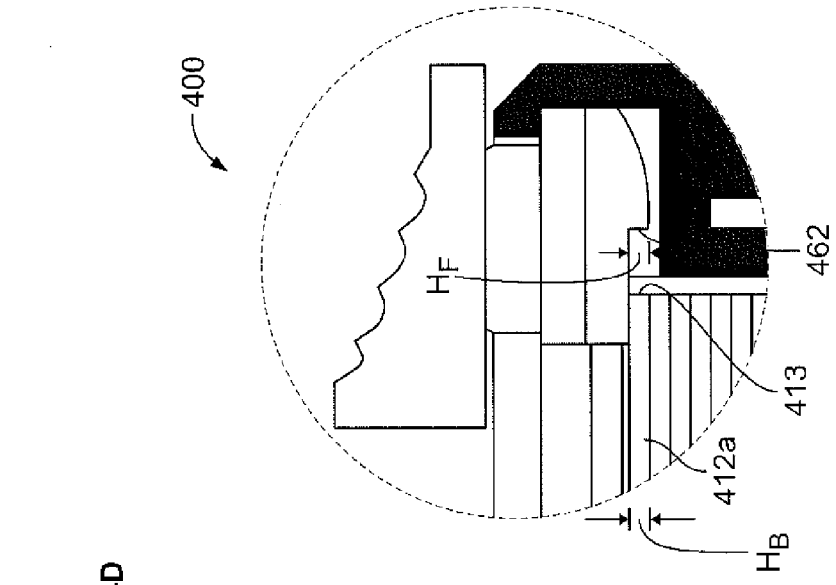


FIG. 4D

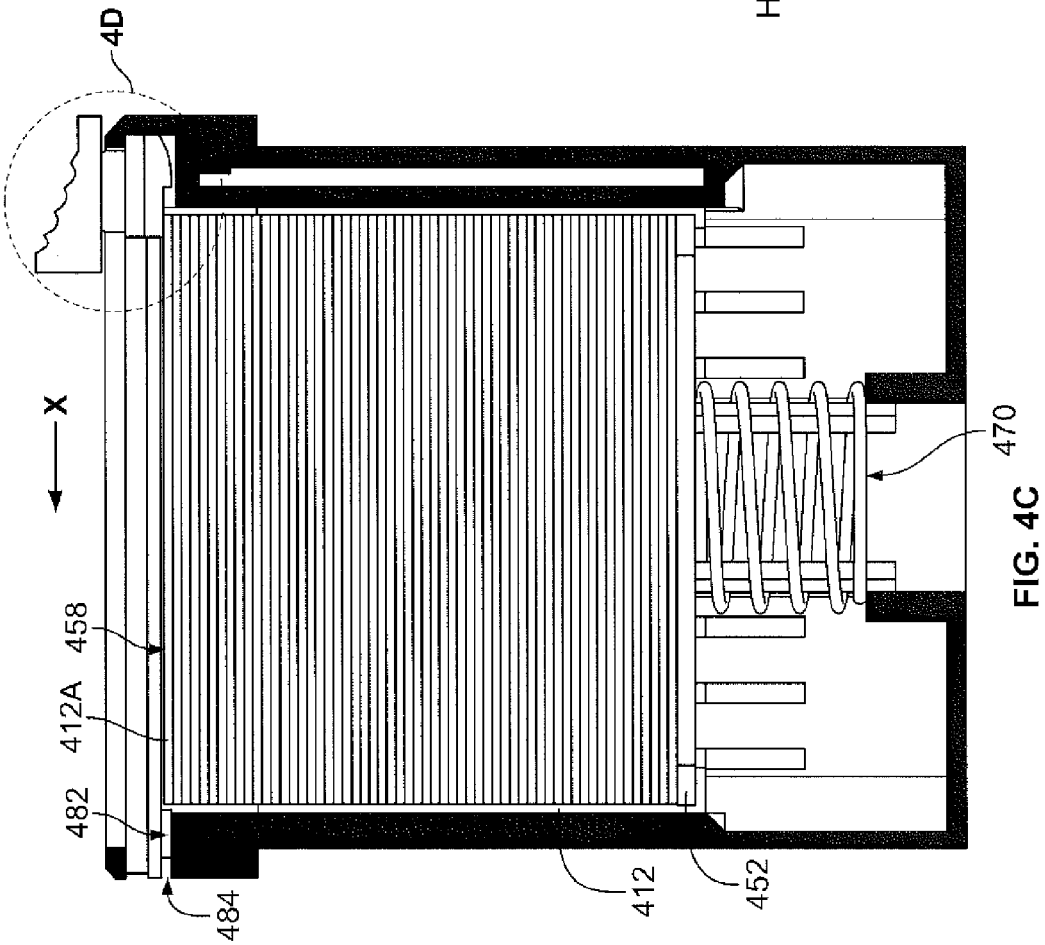


FIG. 4C

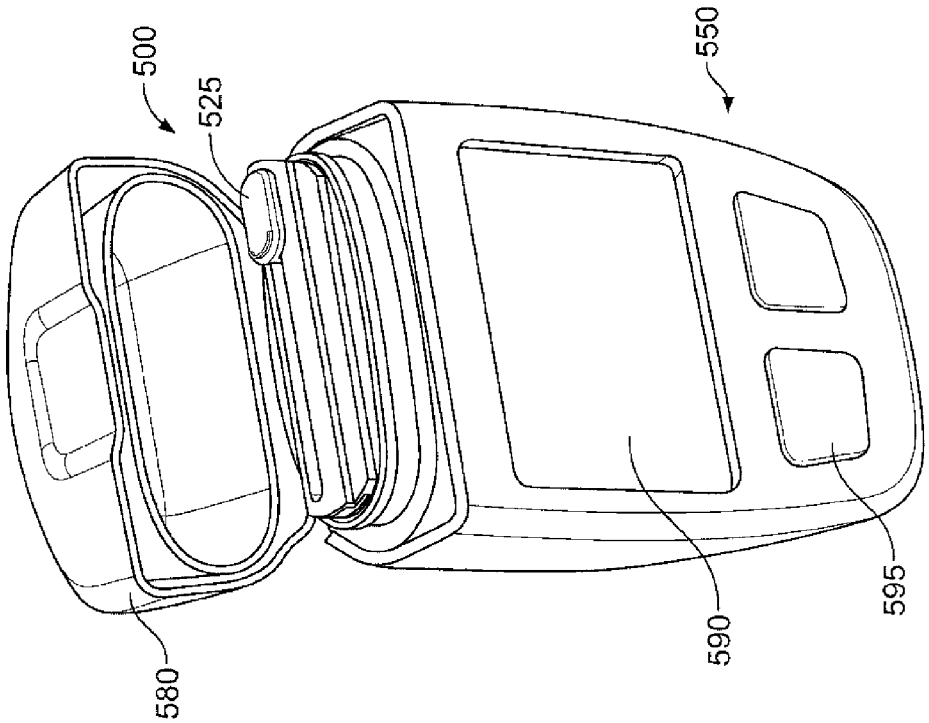


FIG. 5B

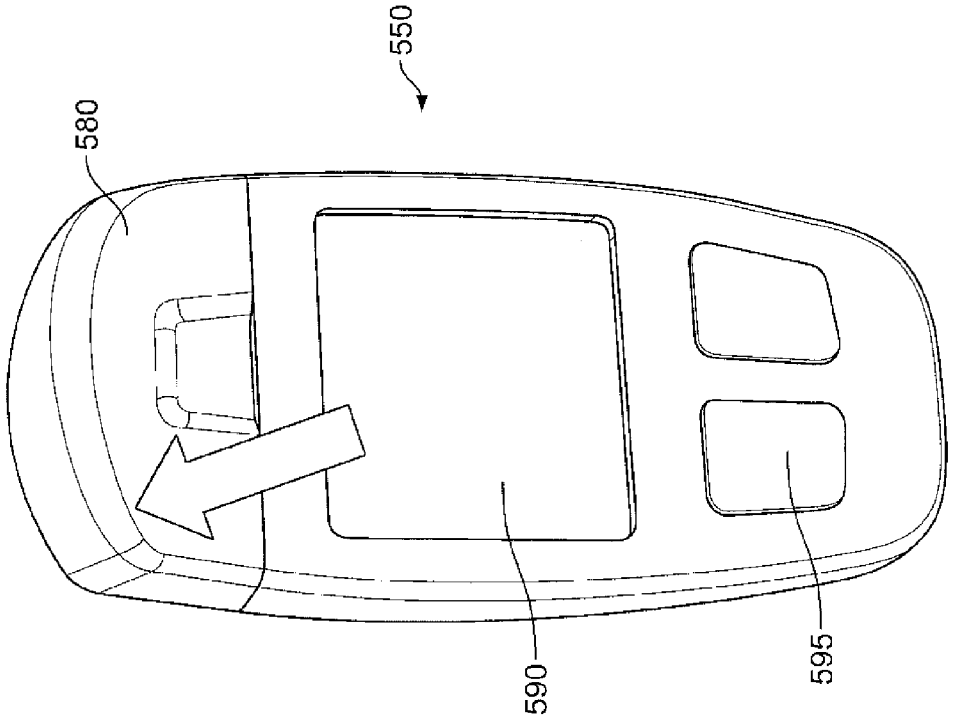


FIG. 5A

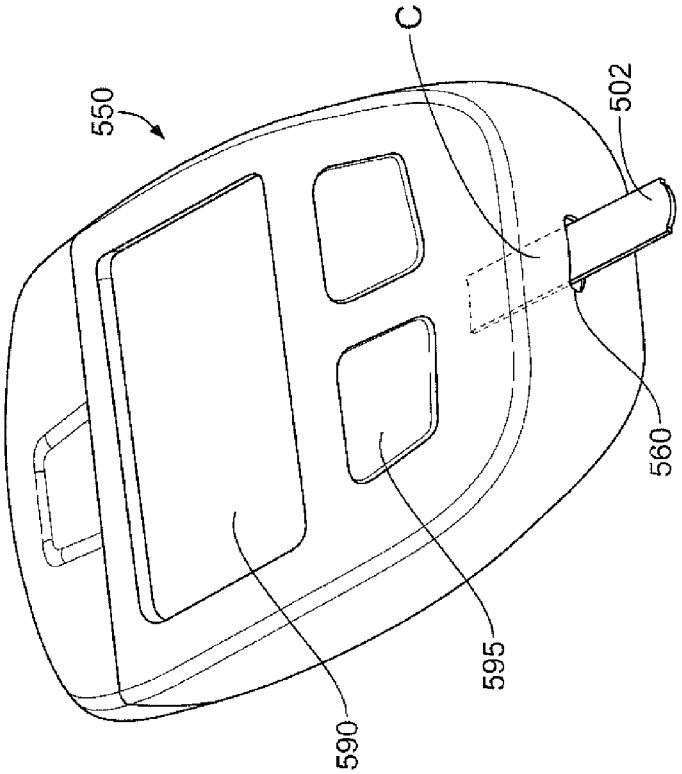


FIG. 5D

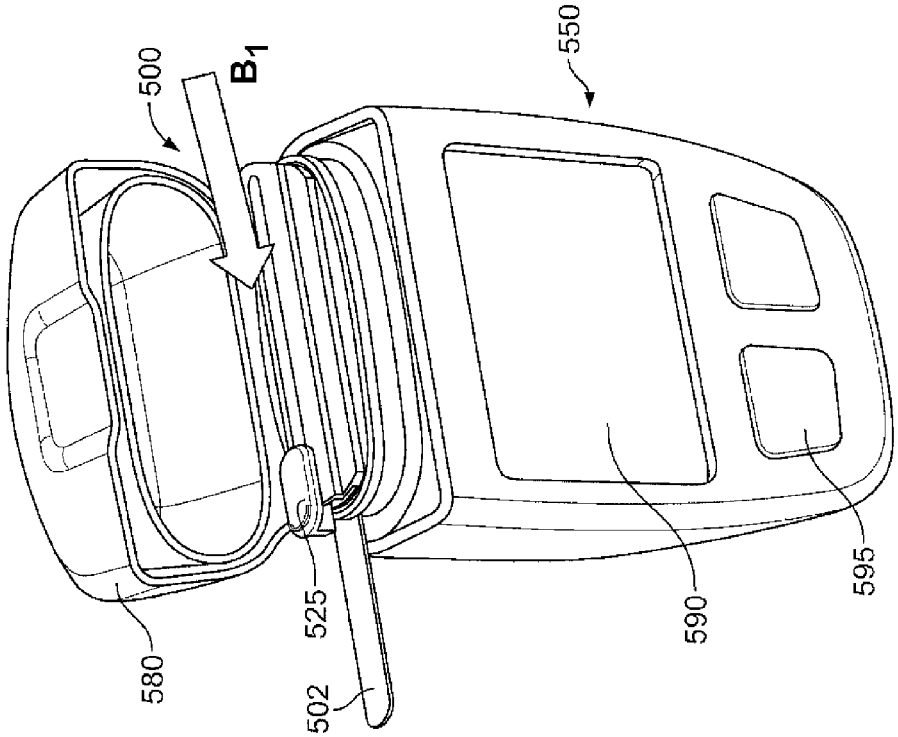


FIG. 5C

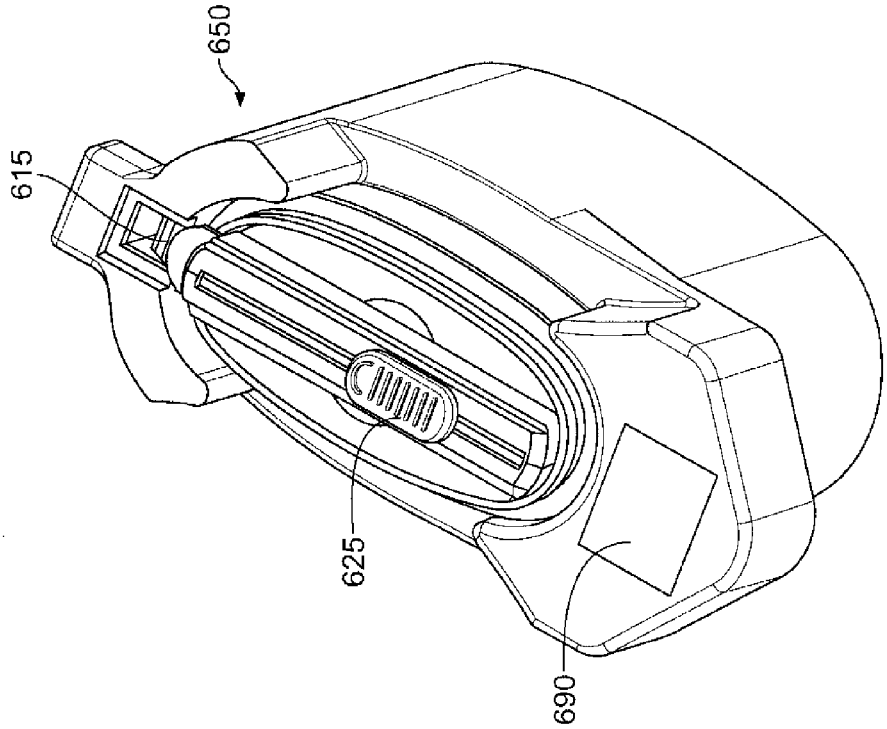


FIG. 6B

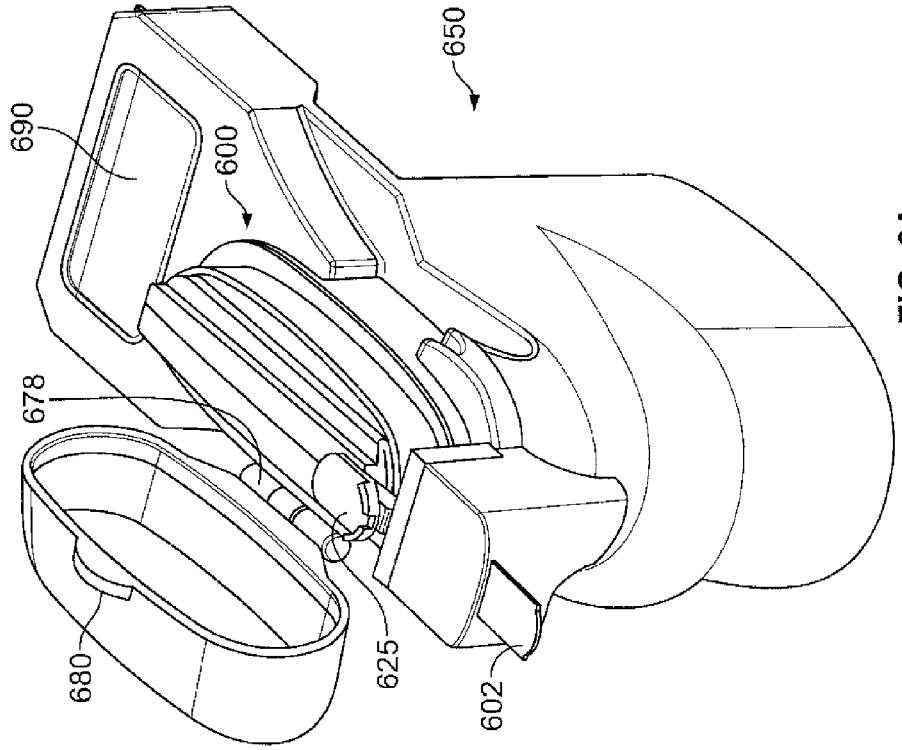


FIG. 6A

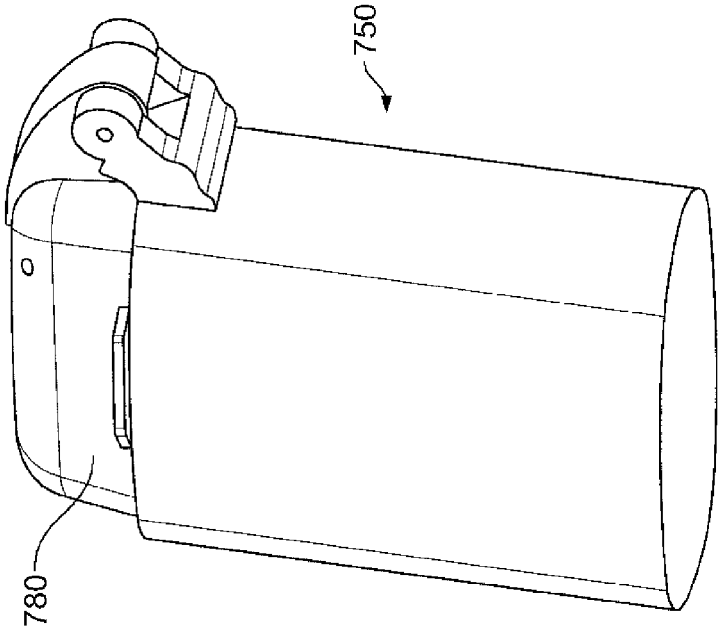


FIG. 7A

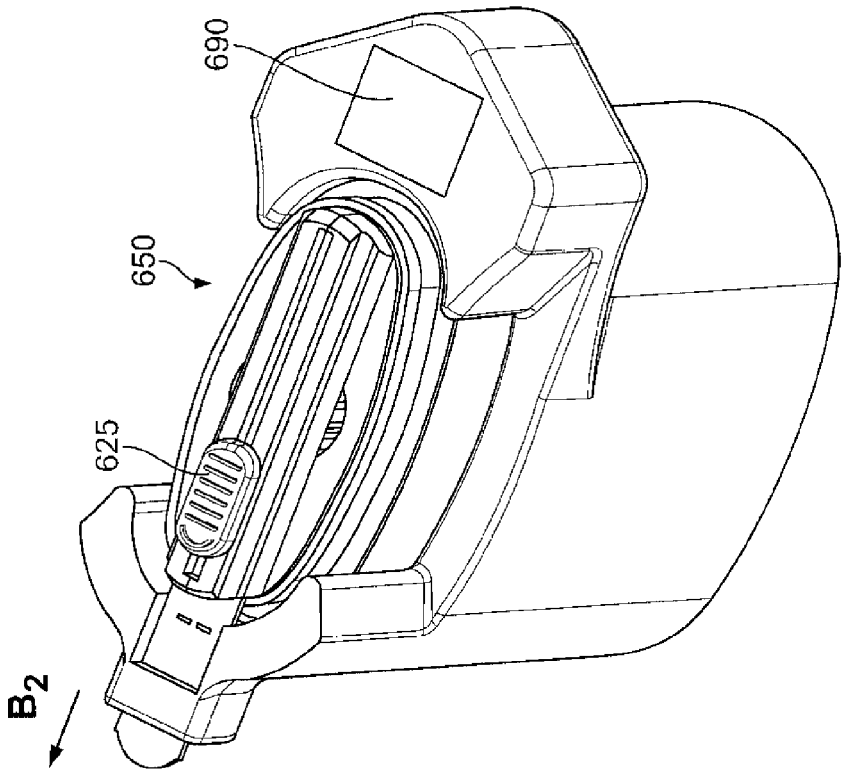


FIG. 6C

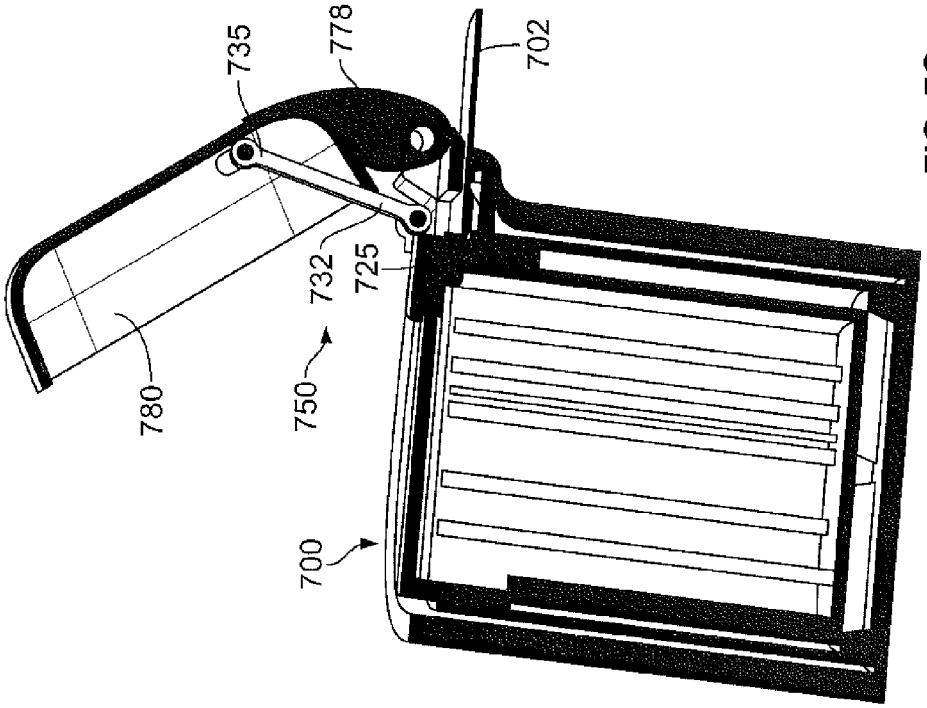


FIG. 7C

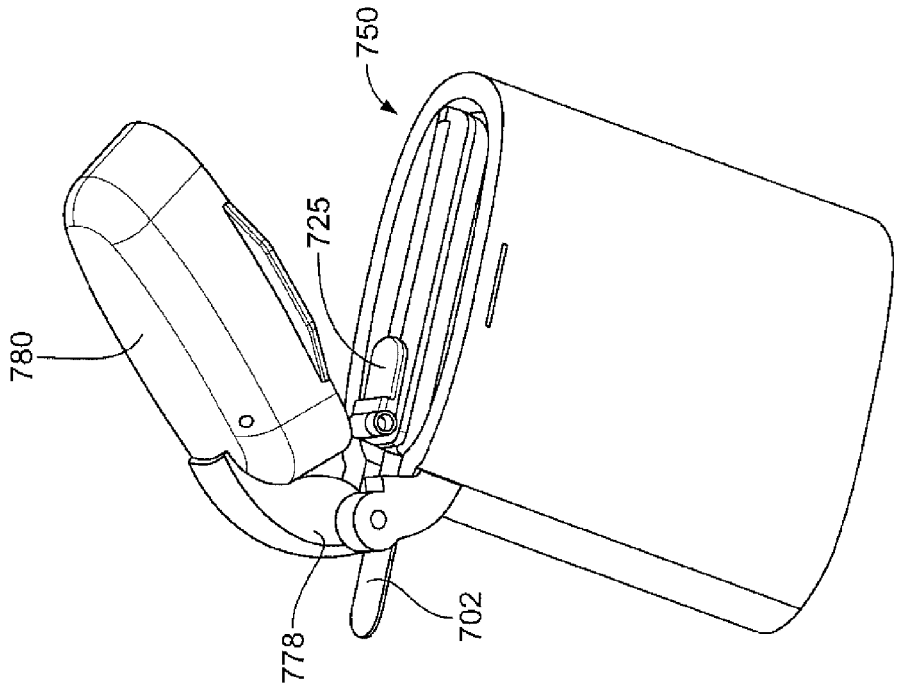


FIG. 7B

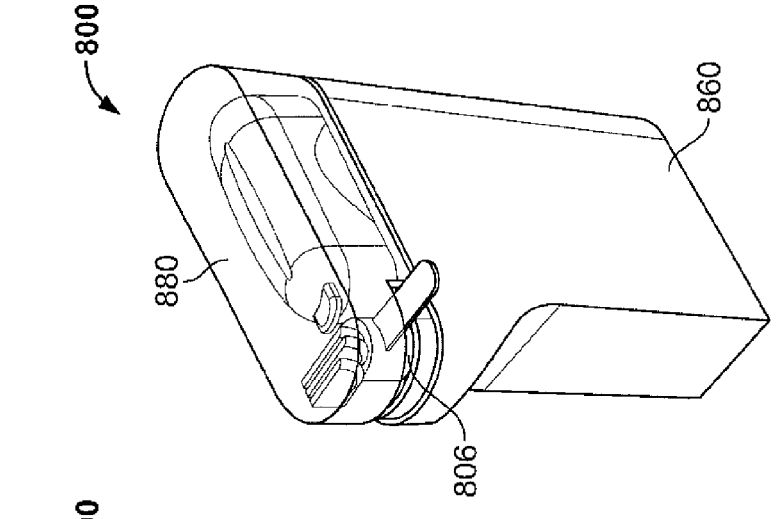


FIG. 8C

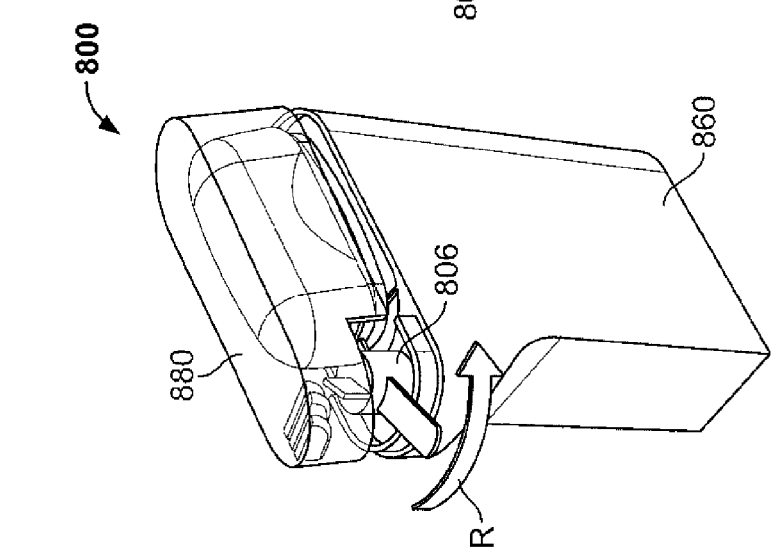


FIG. 8B

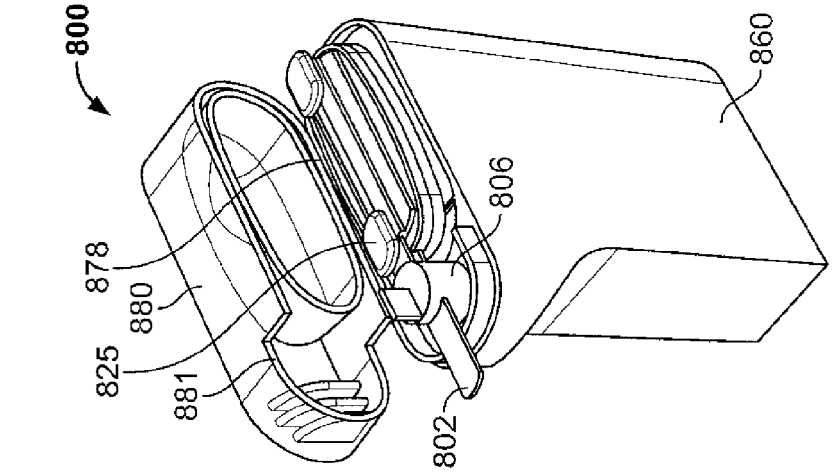


FIG. 8A

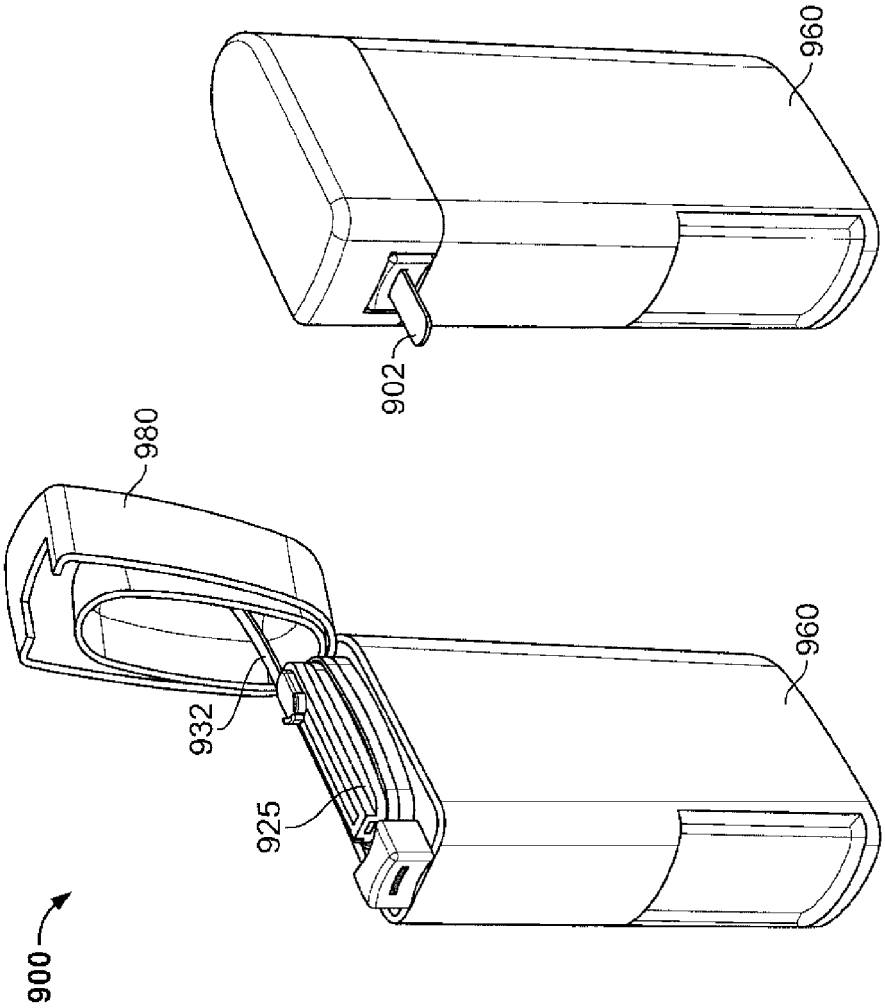


FIG. 9C

FIG. 9B

FIG. 9A

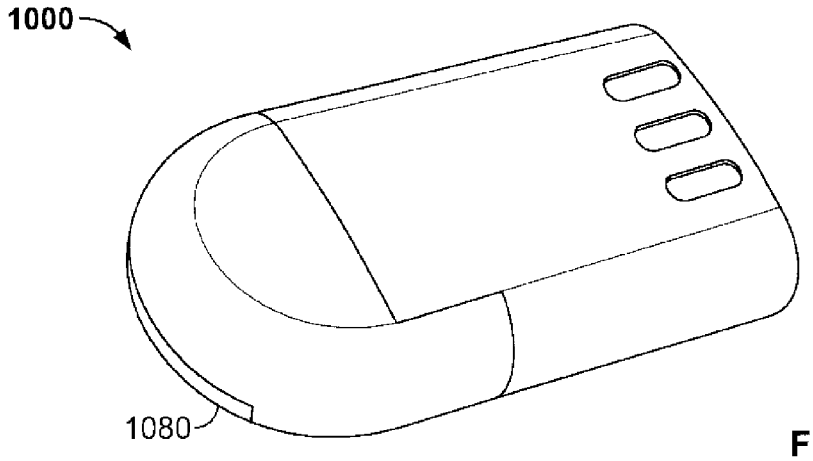
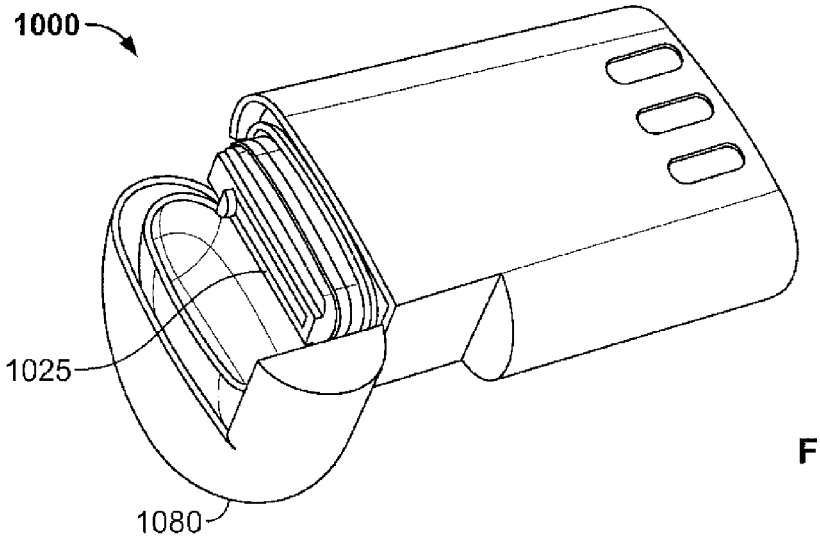


FIG. 10A



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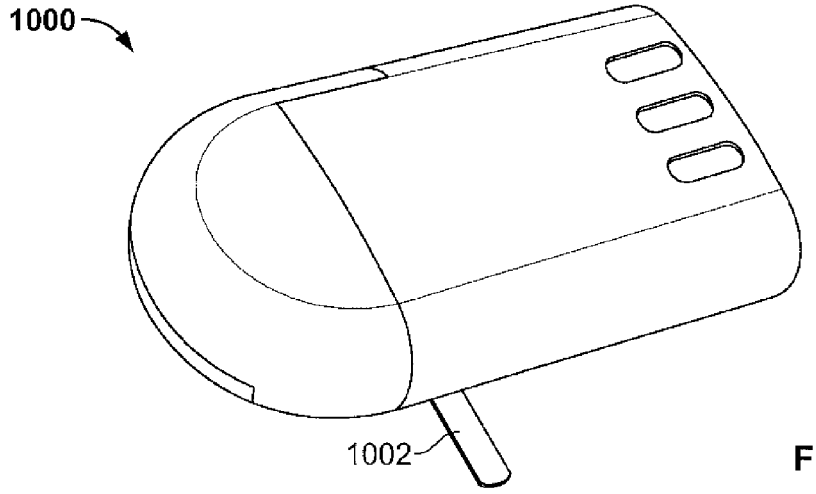

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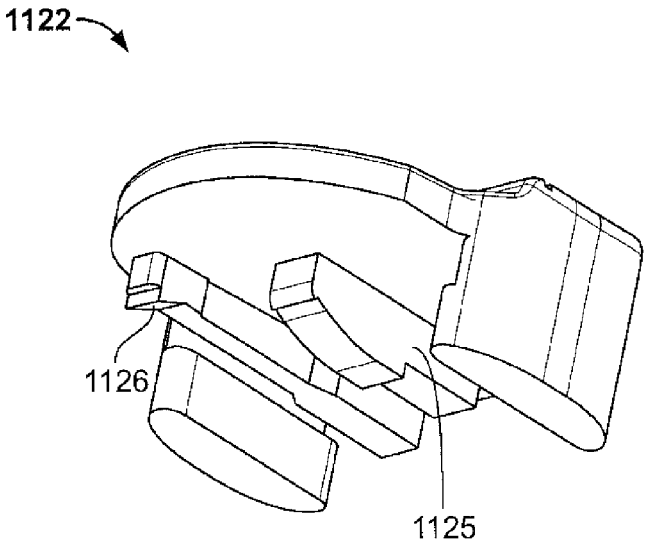

FIG. 11A

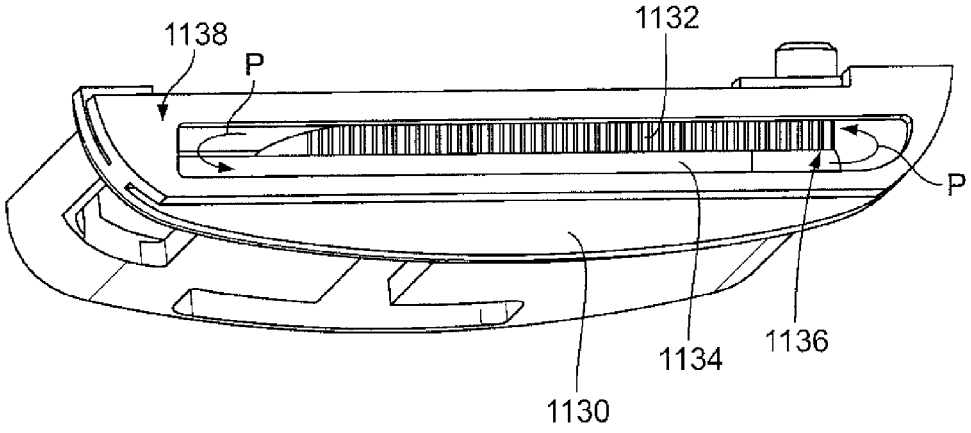

FIG. 11B

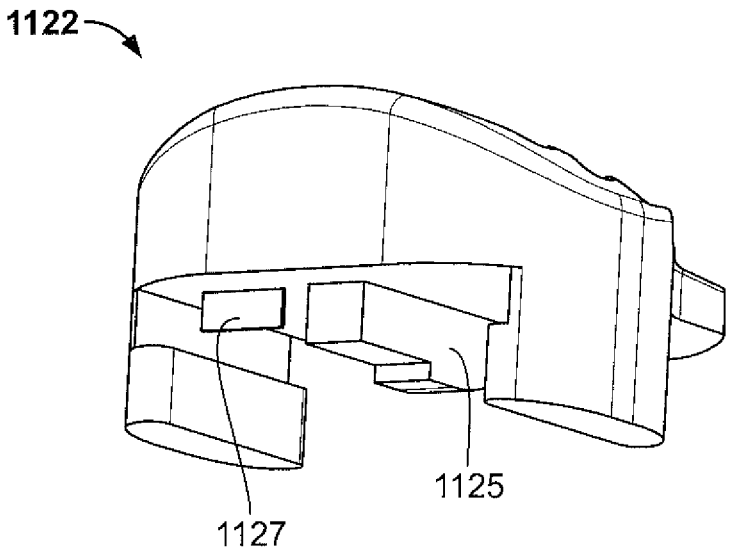

FIG. 11C

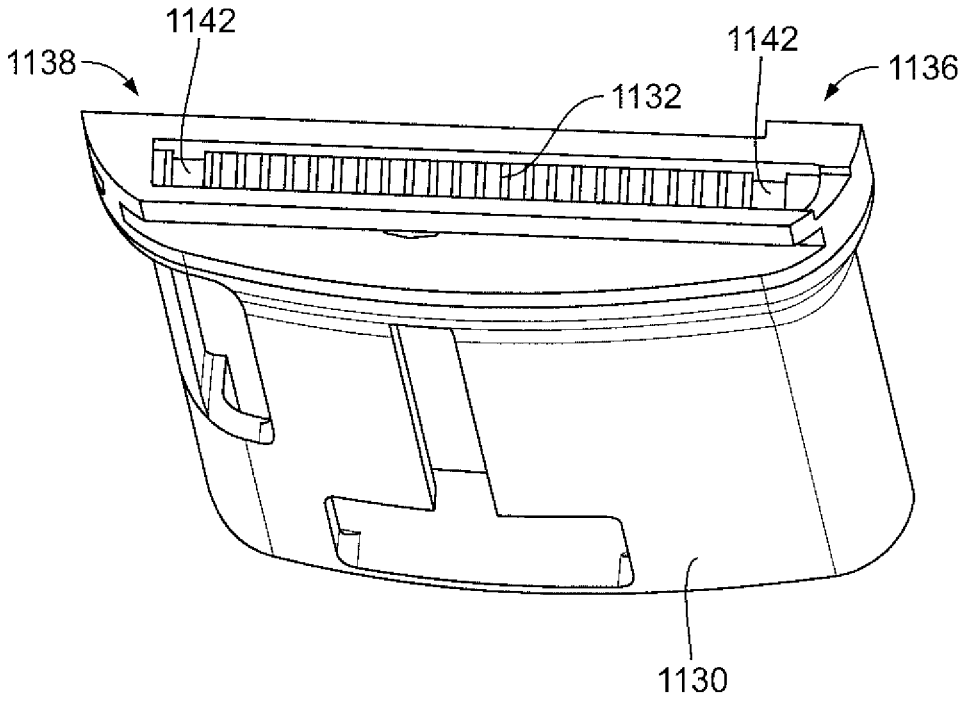

FIG. 11D

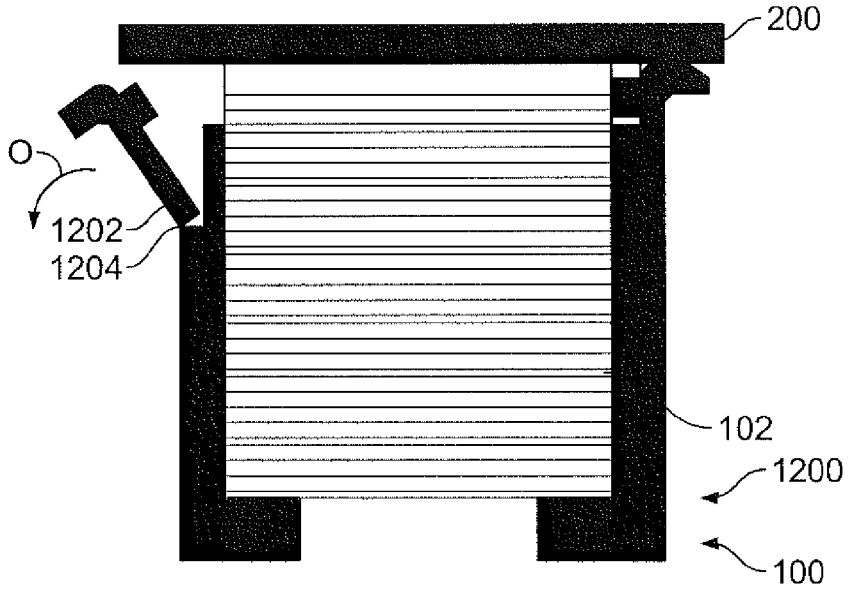

FIG. 12A

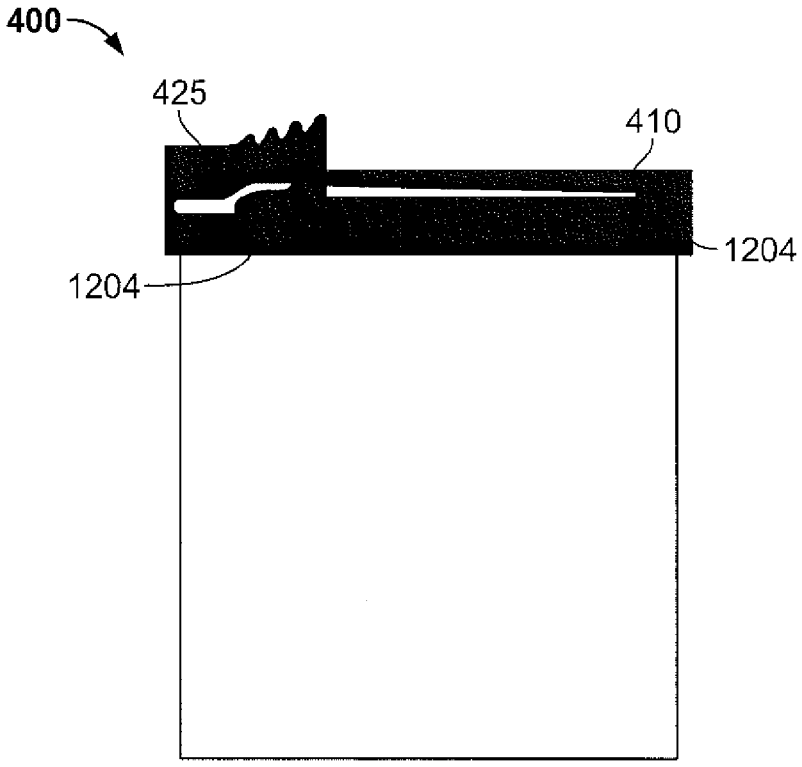

FIG. 12B

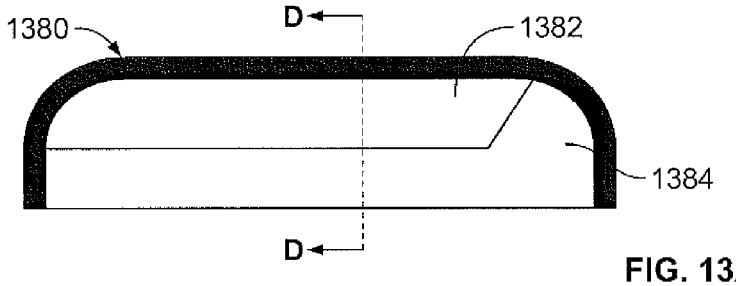

FIG. 13A

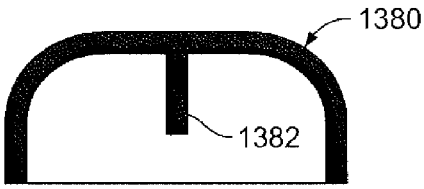

FIG. 13B

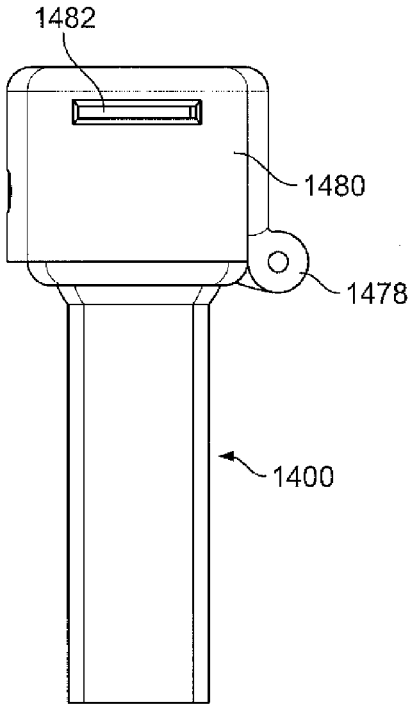

FIG. 14A

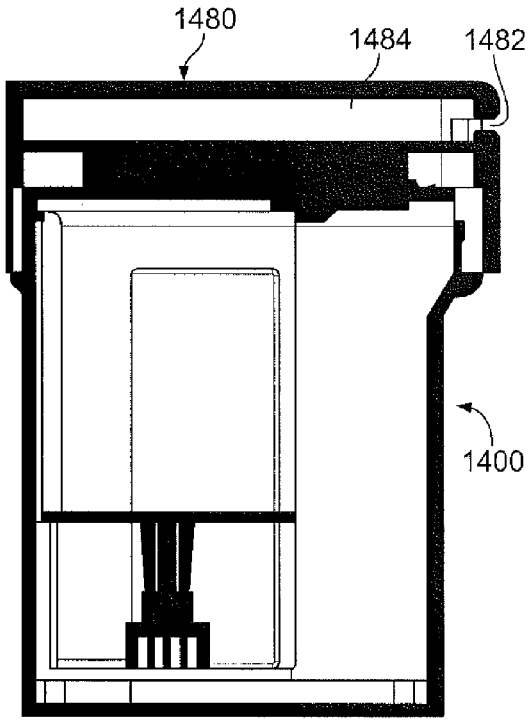

FIG. 14B

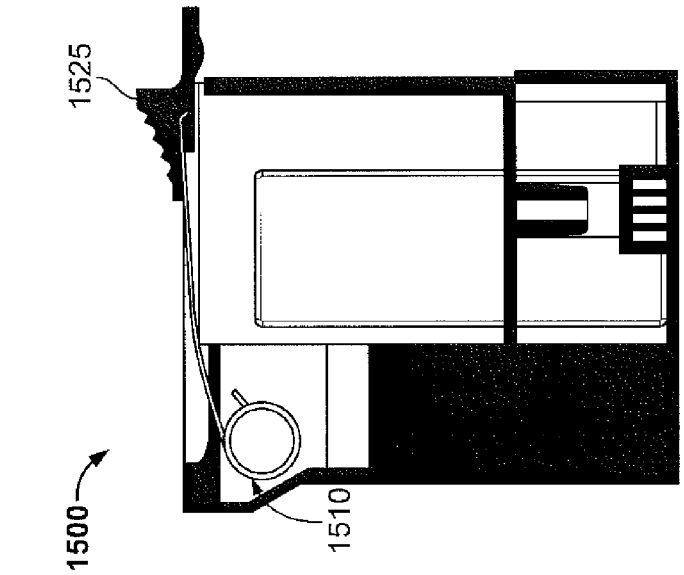

FIG. 15C

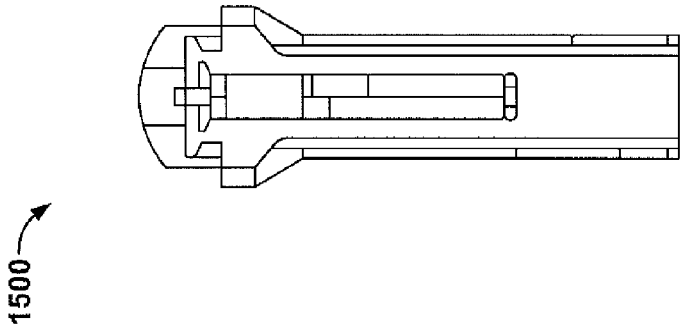

FIG. 15B

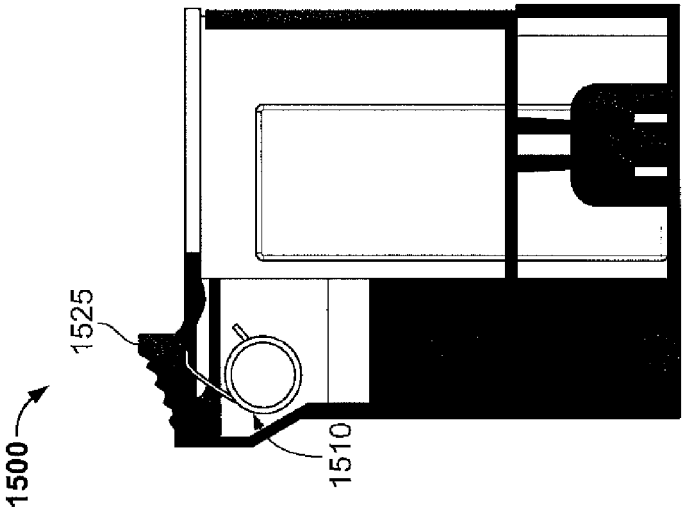

FIG. 15A

REPLACEABLE MULTISTRIP CARTRIDGE AND BIOSENSOR METER

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims the benefit of Provisional Application Ser. No. 61/653,603, filed May 31, 2012, entitled Replaceable Multistrip Cartridge and Biosensor Meter, the disclosure of which is hereby incorporated herein by reference.

BACKGROUND OF THE INVENTION

The present invention relates generally to blood glucose monitoring systems for determining the concentration of glucose in blood, and more particularly, to a sensor cartridge for dispensing biosensors for use with blood glucose monitoring systems.

It is often necessary to quickly obtain a sample of blood and perform an analysis of the blood sample. One example of a need for obtaining a sample of blood is in connection with a blood glucose monitoring system, which a user must frequently use to monitor the user's blood glucose level.

Those who have irregular blood glucose concentration levels are medically required to regularly self-monitor their blood glucose concentration level. An irregular blood glucose level can be brought on by a variety of reasons, including illness, such as diabetes. The purpose of monitoring the blood glucose concentration level is to determine the blood glucose concentration level and then to take corrective action, based upon whether the level is too high or too low, to bring the level back within a normal range. The failure to take corrective action can have serious implications. When blood glucose levels drop too low, a condition known as hypoglycemia, a person can become nervous, shaky and confused. That person's judgment may become impaired and that person may eventually pass out. A person can also become very ill if their blood glucose level becomes too high, a condition known as hyperglycemia. Both conditions, hypoglycemia and hyperglycemia, are potentially life-threatening emergencies.

One method of monitoring a person's blood glucose level is with a portable, hand-held blood glucose testing device. The portable nature of these devices enables the users to conveniently test their blood glucose levels wherever the user may be. The glucose testing device includes a biosensor to harvest the blood for analysis. One type of biosensor is the electrochemical biosensor. The electrochemical biosensor includes a regent designed to react with glucose in the blood to create an oxidation current at electrodes disposed within the electrochemical biosensor which is directly proportional to the user's blood glucose concentration. Such a biosensor is described in U.S. Pat. Nos. 5,120,420, 5,660,791, 5,759,364, and 5,798,031, each of which is incorporated herein in its entirety. Another type of sensor is an optical biosensor, which incorporates a reagent designed to produce a colorimetric reaction indicative of a user's blood glucose concentration level. The colorimetric reaction is then read by a spectrometer incorporated into the testing device. Such an optical biosensor is described in U.S. Pat. No. 5,194,393, which is incorporated herein by reference in its entirety.

In order to check a person's blood glucose level, a drop of blood is obtained from the person's fingertip using a lancing device, and the blood is harvested using the biosensor. The biosensor, which is inserted into a testing unit, is brought into contact with the blood drop. The biosensor draws the blood, via capillary action, inside the biosensor and the ensuing electrochemical reaction is measured by the test unit, which then determines the concentration of glucose in the blood. Once the results of the test are displayed on a display of the test unit, the biosensor is discarded. Each new test requires a new biosensor.

Referring now to FIGS. **1** and **2**, examples of a testing device **10** and a package **30** of biosensors **12** ("sensor pack") are shown, respectively. The sensor pack **30** is designed to be housed within the testing device **10**. Prior to each test, a collection area **14** of an individual biosensor **12** is pushed by a mechanism within the testing device **10** through its packaging and is extended from the testing device **10** through a slot **16** for harvesting a sample of blood. The testing device **10** includes a slider **18** for advancing the biosensor **12**. In FIG. **1**, a biosensor **12** is shown extending from the testing device **10**. The collection area **14** extends from the testing device **10**, while a contact area, disposed at the opposite end of the biosensor **12**, shown in FIGS. **1** and **2**, remains inside the testing device **10**. The contact area includes terminals that electrically couple the electrodes to a meter disposed within the testing device **10** for measuring the oxidation current produced at the electrodes by the reaction of glucose and the reagent. The test unit includes a display **20**.

Referring now to FIG. **2**, biosensors **12** are shown disposed in the sensor pack **30**. The sensor pack **30** is made up of a circular disk **32** having ten individual compartments (blisters) **34** arranged radially. The disk is made from an aluminum foil/plastic laminate which is sealed to isolate the sensor from ambient humidity and from other sensors with a burst foil cover **36**. Each biosensor **12** is kept dry by a desiccant located inside a desiccant compartment **37** disposed adjacent to the compartment **34**.

To retrieve a sensor, a mechanism disposed within the testing device **10**, such as a knife, is driven down through the burst foil into an individual elongated compartment **34** at the end closest to the hub of the disk **32** and then moved radially toward the perimeter of the blister **34**. In doing so, the knife engages the contact area **38** (fish tail) of the sensor in that compartment. Radial travel of the knife pushes the tip of the sensor out through the burst foil **36** and through parts of the testing device **10** such that the collection area **14** of the sensor **12** is completely out of the testing device **10** and ready to receive a fluid test sample such as blood. For this stage, it is essential that the bond between the base and lid of the sensor withstand the sheer forces generated when the sensor bursts out through the foil **36**. This method of providing a sensor ready for use is more fully described in U.S. Pat. No. 5,575,403, which is incorporated herein by reference in its entirety.

Further details of the operational and mechanical aspects of the testing device **10** and sensor pack **30** are more fully described in U.S. Pat. Nos. 5,575,403, 5,630,986, 5,738,244, 5,810,199, 5,854,074, 5,856,195 and 8,105,536, each of which are hereby incorporated by reference in their entireties.

A drawback associated with this flat array of testing devices is the large area that is occupied. The size of testing devices that internally house such a flat array package constrains the size of the package (i.e., the number of sensors), thus making it difficult to increase the number of sensors per package. Moreover, prior art meter and cartridge assemblies include too many parts that must be replaced with each new cartridge. Finally, sensors must be handled by the user, which decreases the accuracy of the reading. Accordingly, it would be beneficial to provide a replaceable cartridge where the replaceable portions are few and easily assembled to a meter, resulting in a lower cost of use and better accuracy in measurement.

SUMMARY OF THE INVENTION

In some embodiments, a replaceable sensor cartridge includes a frame having at least two walls defining a chamber for accepting a plurality of biosensors, the frame having a bottom portion defining a bore and a sealing flange, the frame further including a desiccant material capable of reducing humidity within the frame. The frame may be dimensioned such that an interference fit temporarily constrains the plurality of sensors prior to inserting the frame within a blood glucose monitor. Alternatively the sensors may be temporarily constrained by a thin bead of a hot-melt adhesive.

In some other embodiments a blood glucose monitor includes a can capable of accepting a replaceable sensor cartridge. An upper spring may be disposed between the frame and the can. A case for housing the can may seal the frame. A lower spring may be disposed between the can and the case. A meter housing may seal an upper portion of the frame.

In some other examples, a replaceable sensor cartridge may include a housing, a frame disposed within the housing for accepting a plurality of biosensors, and a spring for actuating the plurality of biosensors. A strip picker may be configured and arranged to slide along a top portion of the frame to deploy the top biosensor from the plurality of biosensors. The blood glucose monitor may further include an acceptance slot at the bottom of the monitor for receiving a sample placed on a biosensor. At least one electrode at the top of the housing may be configured and arranged to contact a biosensor coupled to a strip picker. Other variations may include an arm for coupling the lid to a strip picker such that movement of the lid actuates the strip picker.

BRIEF DESCRIPTION OF THE DRAWINGS

Various embodiments of the presently disclosed delivery system are disclosed herein with reference to the drawings, wherein:

FIG. **1** is a perspective view of a prior art testing device;

FIG. **2** is a perspective view of a prior art sensor pack having a foil lid removed;

FIGS. **3**A-E are schematic cross-sectional views of a replaceable cartridge and its use within a meter according to one embodiment of the present invention;

FIG. **3**F is a schematic cross-sectional view of another example of a replaceable cartridge having a lift platform according to another embodiment of the present invention;

FIGS. **4**A and **4**B are perspective views of a sensor cartridge having a picker according to one embodiment of the present invention;

FIGS. **4**C and **4**D are schematic cross-sectional view of the cartridge shown in FIG. **4**A;

FIGS. **5**A-D are perspective views of a blood glucose monitor and a sensor cartridge disposed within the monitor according to one embodiment of the present invention;

FIGS. **6**A-C are perspective views of a blood glucose monitor and a sensor cartridge disposed within the monitor according to another embodiment of the present invention;

FIGS. **7**A-C are perspective views of a blood glucose monitor and a sensor cartridge disposed within the monitor according to a third embodiment of the present invention;

FIGS. **8**A-C are perspective views of a blood glucose monitor and a sensor cartridge disposed within the monitor according to a fourth embodiment of the present invention;

FIGS. **9**A-C are perspective views of a blood glucose monitor and a sensor cartridge disposed within the monitor according to a fifth embodiment of the present invention;

FIGS. **10**A-C are perspective views of a blood glucose monitor and a sensor cartridge disposed within the monitor according to a sixth embodiment of the present invention;

FIGS. **11**A and **11**B are perspective views of a slider and associated can according to another embodiment of the present invention;

FIGS. **11**C and **11**D are perspective views of a slider and associated can according to another embodiment of the present invention;

FIG. **12**A is a schematic cross-sectional view of a replaceable cartridge having an anti-jamming feature according to one embodiment of the present invention;

FIG. **12**B is a schematic side view of a replaceable cartridge having a feedback feature according to one embodiment of the present invention;

FIGS. **13**A and **13**B are schematic cross-sectional views of a lid according to one embodiment of the present invention;

FIGS. **14**A and **14**B are back end and schematic cross-sectional views of a replaceable cartridge having a disposal compartment according to one embodiment of the present invention; and

FIGS. **15**A-C are schematic illustrations of a replaceable cartridge having a retraction spring according to one embodiment of the present invention.

Various embodiments of the present invention will now be described with reference to the appended drawings. It is appreciated that these drawings depict only some embodiments of the invention and are therefore not to be considered limiting of its scope.

DETAILED DESCRIPTION

Referring now to FIG. **3**A, there is shown a sensor cartridge **100** for storing a plurality of biosensors **102**, such as the biosensors **12** described in connection with FIGS. **1** and **2**, according to one embodiment of the present invention. The sensor cartridge **100** provides a sealed, substantially moisture-impervious environment for storing the plurality of biosensors **102**. According to one embodiment of the sensor cartridge **100**, the plurality of biosensors **102** are stacked, substantially one on top of the next, as shown in FIG. **3**A. In this configuration, outer edges of biosensors **102** are vertically aligned with one another. Generally, in use, the biosensors **102** are dispensed from the sensor cartridge **100** adjacent sealing flange **106**. Sealing flange **106** may be formed of a single continuous radially projecting portion disposed around the circumference of desiccant material **108** or may include two or more separate portions. Supplying sensors in a cartridge is more convenient for a user when compared to a bottle. First, the cartridge provides a storage place for the sensors in a low-humidity environment and permits a smaller, less expensive sensor that, with minimal manipulation can be advanced into the meter, typically by the movement of a lever.

The stacked biosensors **102** are in vapor communication with a desiccant material **108** disposed within the sensor cartridge **100**. The desiccant material **108** maintains the interior of the can **250** at an appropriate humidity level so that the reagent material disposed within the biosensors **102** is not adversely affected prior to being used. The desiccant material **108** is in the form of a small bag, round bead of material, a hot melt, a molded shape or any other form that can be readily disposed in the sensor cartridge **100**. Sufficient desiccant is added to cover use-life, but not necessarily shelf-life of the package. A desiccated over-foil or other packaging may be needed for additional moisture protection. While the desiccant material **108** shown (FIG. **3**A) is disposed towards a portion of the sides and bottom of the sensor cartridge **102**,

the desiccant material **108** may be disposed anywhere practical within the sensor cartridge **100** according to alternative embodiments of the sensor cartridge **100**. The amount of such desiccant material **108** placed within the sensor cartridge **100** will be dependent on the amount that is required to maintain the interior of the sensor cartridge **100** in a desiccated state. One type of commercially available desiccant material that can be used in one embodiment of the present invention is 13× synthetic molecular sieves from Multisorb Technologies Inc. of Buffalo, N.Y., available in powder, pellet and bead forms.

The sensor cartridge **100** is made of a rigid or semi-rigid material such as plastic that forms a frame. The material may be moisture-impervious. Each of the biosensors are approximately 0.50 inch long (about 12.70 mm), approximately 0.03 inch thick (about 0.76 mm) and approximately 0.20 inch wide (about 5.08 mm). The interior of the of the sensor cartridge **100** is dimensioned only slightly larger than the length and width of the biosensors **120** to allow the biosensors **102** to move vertically within the sensor cartridge (as described below) but not side-to-side (as viewed in FIG. **3**A) so that the stack of the biosensors **102** is maintained. For example, according to one embodiment of the sensor cartridge **100**, the sensor cartridge **100** has an interior width W of approximately 0.52 inch (about 13.21 mm) and an interior depth (into the page as viewed in FIG. **3**A) of approximately 0.22 inch (about 5.59 mm). The interior height H may be approximately 2.25 inch (about 57.15 mm) for an embodiment of the sensor cartridge that is adapted to houses approximately fifty sensors. The interior height H may be varied according to alternative embodiments of the sensor cartridge **100** to accommodate an increased or decreased number of biosensor **102**.

In some examples, the top opening of sensor cartridge **100** may deliberately have slightly different dimensions from biosensors **102** to cause a small amount of interference which serves to hold biosensors **102** in place during manufacture and while sensor cartridge **100** is being loaded into the meter as will be described below.

The frame of cartridge **100** may include walls to house biosensors **102**. In at least some examples, the frame may include two opposing walls with two open edges therebetween. Alternatively, the frame may include three or four walls. As seen in FIG. **3**A, the frame of sensor cartridge **100** may further include a bore **104** at the bottom of the cartridge. Bore **104** may be configured as any opening, lumen, slot or hole capable of accepting an actuator for pushing biosensors **102** upward. In one example, bore **104** may be configured to accept an actuator in the form of a spring (shown in FIG. **3**C) as will be described in greater detail below. Bore **104** provides a channel through which biosensors **102** may be pushed up within cartridge **100**. It will be understood that though FIG. **3**A illustrates a single bore **104**, that multiple bores **104** may be formed in the frame. Additionally, the bore **104** need not be disposed in the middle of the frame, but may be disposed at corners or edges of the frame.

Sensor cartridge **100** may be formed as described as a single unit, and packaged for individual sale. Some sensor storage bottles provide a moisture barrier, a desiccant and a seal but also require additional components related to the delivery process for the sensor such as, for example, an actuator in the form of a lift spring that is needed to push a biosensor off the top of a stacked array of sensors into a nest. Additional components in the cartridge may add to the disposable cost.

In contrast, the embodiment of sensor cartridge **100** includes only the minimum parts necessary for reliable operation of a cartridge system which is the frame (not having six sides) sufficient desiccant for the desired use-life and a seal. The remaining portions necessary for operation of a blood glucose monitor may be formed as part of a reusable meter. In this manner, the cost of the replaceable single-use sensor cartridge **100** may be reduced.

FIG. **3**B illustrates sensor cartridge **100** being loaded in a meter housing **200**. Meter housing **200** may include a taper fitting **204** that will contact sealing flange **106**. During loading a taper fitting **204** in the meter housing **200** engages sensor cartridge **100** and deforms it in such a way as to allow biosensors **102** to move freely. Alternatively, taper fitting **204** or other fitting may be configured to depress a cartridge-latch that otherwise stops the biosensors from falling out. As seen in FIG. **3**B, the assembled meter housing **200** and sensor cartridge **100** defines a segregating slot **202** that will allow individual deployment of biosensors **102**. In this manner, only one biosensor **102** is deployed at a time and jamming in the assembly is reduced.

A can **250** and case **260** may be coupled to the meter housing **200** as seen in FIG. **3**C. A water-impermeable can **250** may be disposed within a meter case **260** and configured to be capable of sliding within case **260**. Can **250**, case **260** or both may be configured to include a stop mechanism so that can **250** does not decouple from case **260**. An actuator in the form of an upper spring **270** may be disposed within can **250** and passed through bore **104** of sensor cartridge **100** to actuate biosensors **102**. A pair of lower springs **272** may be disposed between can **250** and case **260**. As cartridge **100** is pushed into can **250** and case **260**, upper spring **270** pushes biosensors **102** up to the delivery surface of the meter housing **200**. Lower spring **272** in combination with case **260** forces can **250** against sealing flange **260** and housing **200** to create a sealed environment within can **250**. Lower spring **272** in case **250** pushes the can onto sealing flange **106**, which is trapped between the can **250** and meter housing **200**, sealing biosensors **102** in a desiccated environment. In one example, the spring force of lower spring **272** may be higher than that of upper spring **270** to hold can **250**, flange **106** and housing **200** together in a sealed configuration. This is the rest, or storage position of the assembly. It will be understood that upper springs **270** and lower springs **272** may each include a single spring, or multiple springs having the same or varying spring constants. In addition to upper and lower springs, the actuator may include other components for translating biosensors **102** upward toward a feed mechanism so that the biosensors may be used. For example, the actuator may include a manual lift platform **195** disposed under the lowermost biosensor **102**. and projecting out of a bore **104** in the side of cartridge **100** as shown in FIG. **3**F. The lift platform may be manually pushed upward to move the biosensors **102** toward the feed mechanism. The actuator may include other biased or unbiased components to translate the biosensors.

As seen in FIGS. **3**C-**3**E a pusher **300** may be used to advance a single biosensor **102** out of sensor cartridge **102**. As shown in FIG. **3**D, as pusher **300** approaches, can **250** is slightly pushed downward, relieving pressure from sealing flange **106** of the cartridge **100**. As pusher **300** advances further, as shown in FIG. **3**D, the pusher contacts the chamfered edge of the seal and lifts the can out of the way. Segregating slot **202** ensures that just one biosensor **102** is delivered by pusher **300** at a time.

FIG. **4**A illustrates a second embodiment of a sensor cartridge **400** for storing a plurality of biosensors (not shown). Sensor cartridge **400** provides a sealed, substantially moisture-impervious environment for storing the plurality of biosensors. Cartridge **400** may be made of a rigid or semi-rigid material such as plastic that forms a frame. Common materials used to form cartridge **400** include thermoplastics. In this

embodiment, cartridge **400** has an overall oval shape, although any desired shape can be used. Unlike cartridge **100**, sensor cartridge **400** does not include a bottom opening, and thus biosensors disposed within sensor cartridge **400** are completely sealed from the atmosphere until biosensors are ejected. Cartridge **400** can therefore be used as a stand-alone cartridge packaged for individual use or cartridge **400** can be directly incorporated into a meter. When cartridge **400** is utilized as a stand-alone cartridge for individual consumer use, cartridge **400** allows an individual user to store and dispense biosensors. The size and shape of cartridge **400** permit a user to hold cartridge **400** in the palm the user's hand, as well as place cartridge **400** in the user's pocket. Cartridge **400** also permits a user to deposit a fluid sample onto the biosensor and place the biosensor into a meter without having to physically contact or touch a biosensor stored therein. Of course, if cartridge **400** is incorporated into the design of a test sensor (as will be discussed in embodiments herein), a user is able to physically pull the biosensor from cartridge **400** and place it into a test meter.

According to one embodiment, the plurality of biosensors is stacked, substantially one on top of the next. Each biosensor has a first edge **413** and a second edge **415**, the first and second edges **413**,**415** being aligned with one another. Sensor cartridge **400** includes a can **430** disposed within a case **440**. Sensor cartridge **400** is different from cartridge **100** in that it includes cap portion **410** having an integrated picker **425**. Picker **425** may be configured to horizontally slide along cap portion **410** on a track. The edge of picker **425** may also be configured to couple or engage a biosensor to push the biosensor out of cartridge **400**, as will be more fully explained.

FIGS. **4**B-**4**C illustrate sensor cartridge **400** without case **400** (and with FIG. **4**B not including biosensors). As best seen in FIG. **4**C, a plurality of biosensors **412** are supported in can **412** by a base **452** biased toward the top **458** of sensor cartridge **400**. Spring **470** is capable of driving the base **452** and biosensors to the top of cartridge **400** near picker **425**. Alternative mechanisms may also be used to urge base **470** and/or biosensors **412** to the top of cartridge **400**. For example, a pawl and ratcheting mechanism or metering device may be incorporated into the cartridge to provide upward movement of biosensors **412**. Similarly, a dispensing system similar to the design disclosed in copending application U.S. application Ser. No. 13/730,436 filed on Dec. 28, 2012 and entitled Multistrip Cartridge may be utilized, the disclosure of which is incorporated herein by reference. Sensor cartridge **400** may further include a protective lid (not shown) disposed over cap portion **410** to protect the picker **425** from damage during storage or shipment.

FIGS. **4**C and **4**D illustrate a cross-sectional schematic view of can **400** with biosensors **412** stacked therein. Strip picker **400** is shown adjacent a first biosensor **412**A, which is positioned at the top of the stack of biosensors **412**. Strip picker **400** includes a finger **460** with an edge **462** having a height H_F that is slightly smaller than the height H_B of biosensor **412**A. Put another way, height H_B of biosensor **412**A should be slightly greater than a height H_F of finger **460**. For example, if biosensor **412**A has a height H_B of 0.43 mm, height H_F of finger **460** can be slightly less than 0.43 mm, such as 0.35 mm. It is to be appreciated that this embodiment provides only one example and that any size test strip may be utilized. In such alternative embodiments, biosensors will also have a height H_F of finger **460** that is slightly less than the height H_B of the biosensor. Although not limited to such ranges, such alternative embodiments may have a height H_B ranging from 0.30 mm to 0.50 mm and the finger **460** can have a corresponding height H_F ranging from 0.29 mm to 0.49 mm.

In use, the user would open or remove the lid to expose the picker **425**. Picker **425** may be horizontally slid in direction X so that edge **462** of finger **460** engages edge **413** of test strip **412**A. As picker **425** is slid in the horizontal direction X, biosensor **412** moves laterally across the top of the remaining biosensors **412** in the stack. Picker **425** moves first edge **413** of biosensor **412** into exit channel **482** and into opening **484** of can **430**, such that first and second edges **413**,**415** of biosensor **412**A are no longer aligned or collinear with the first and second edges **413**,**415** of the remaining biosensors **412**A in the stack. Once picker travels the length of top track **411** (FIG. **4**A), first edge **413** of biosensor is free or cantilevered. Second edge **415** of biosensor **412**A remains within exit channel **482**, allowing a user to deposit a fluid sample onto biosensor **412**. Even though the picker consistently pushes only one sensor, friction can also drag an adjacent sensor forward. It is the height of the opening **484** which restricts all but one sensor from being pushed forward and out of the cartridge opening. A user may then move cartridge **400** toward a test meter (not shown) and place biosensor **412**A directly into a test meter without being required to touch, handle, or contact biosensor **412**A. The user may then return picker **425** to its original position and close the lid, storing sensor cartridge **400** for future use.

FIGS. **5**A-D illustrate a third embodiment of the device including a sensor cartridge **500** disposed within a blood glucose monitor. Sensor cartridge **500** is similar to sensor cartridge **400** except that it may be used with blood glucose monitor **550**. Blood glucose monitor **550** may include a cavity "C" in the shape of cartridge **500** housed within the monitor, and an acceptance slot **560** for accepting a biosensor **502** into the interior of the monitor. In at least some examples, each sensor cartridge **500** includes a coding on the bottom of the cartridge. This coding may be read by the blood glucose monitor **550** to determine the brand, type or kind of biosensor being used. Due to variation in biosensor manufacturing, this coding may allow blood glucose monitor to be automatically calibrated based on the biosensor being used. In other embodiments, each individual biosensor includes a coding for calibration that is read by the blood glucose monitor **500**. Blood glucose monitor **550** may also include an LCD display **590** and a plurality of functional buttons (e.g., power, display settings, biosensor selection, etc.). The blood glucose monitor **550** further includes buttons **595**, capable of toggling between modes or adjusting for various test strips, for changing settings of display **590** such as contrast and/or color, for powering the device on or off, or for checking to see whether the device is functioning properly, such as checking the battery level.

In use, the user may open lid **580** by flipping lid **580** over hinge **578** at the top of the blood glucose monitor **550** to reveal slide picker **525**. The user may then slide picker **525** across the top of the meter in the direction of arrow "B**1**" to receive a biosensor **502** from cartridge **500**. A blood sample may be placed on biosensor **502** and the sampling biosensor may be introduced into receiving slot **502** in order to obtain a measurement relating to blood glucose on display **590**.

FIGS. **6**A-C illustrate yet another embodiment of a blood glucose monitor **650** having a sensor cartridge **600**. Sensor cartridge **600** may be similar to any of the sensor cartridges discussed above and may include a picker **625** for actuating a biosensor **602**. An optional lid **680** may also be included to protect picker **625** and the top of the assembly.

As seen in FIG. **6**B, blood glucose monitor **650** may include electrodes **615** for contacting biosensor **602** and measuring relevant blood glucose information. In contrast to the embodiment described above with reference to FIGS. **5**A-**5**D,

blood glucose monitor **650** may be used without the user touching biosensors **602**. Instead, the user may open lid **680** over hinge **678** and slide picker **625** in the direction of arrow "B2" to slide out a biosensor **602**. A blood sample may be placed on biosensor **602** and slid back into blood glucose monitor **650** using picker **625** in a reverse direction opposite arrow "B2". Electrodes **615** may contact biosensor **602** and a measurement may be obtained from display **690**. Thus, the user does not need to touch biosensor **602**, which leads to more accurate results.

In at least some examples of this embodiment, lid **680** and other portions of the device may be separable and coupleable to either edge of the blood glucose monitor **650** or the sensor cartridge **600** such that the device may be used by both right-handed and left-handed users. In such an embodiment, two hinges **678** may be disposed on either side of the sensor cartridge **600** such that lid **680** may be coupled and pivoted over either hinge. The symmetry of the device allows for simple conversion between right-handed and left-handed configurations.

In another embodiment, shown in FIGS. **7**A-C, a semi-automated blood glucose monitor **750** is shown. Blood glucose monitor **750** may be similar to blood glucose monitor **650** except for the configuration of lid **780**. In this example, lid **780** is connected at the back of blood glucose monitor **750** at hinge **778** and may be coupleable to sled **725** on sensor cartridge **700** via ribbon **732** such that opening of lid **780** also functions to pull sled **725** to deploy a biosensor **702** as shown in FIGS. **7**B and **7**C. In at least some examples, lid **780** may be coupleable to sled **725** via arm **735**. As seen in FIGS. **7**B and **7**C, by opening lid **780**, biosensor **702** is pulled out and placed in a position to deposit a blood sample on biosensor **702**. Closing lid **780** moves sled **725** back into its original position.

FIGS. **8**A-C, **9**A-C and **10**A-C illustrate several variations of the embodiments disclosed herein. FIGS. **8**A-C illustrates a pass-through and re-orient embodiment of a sensor cartridge **800**. Sensor cartridge **800** may be similar to sensor cartridge **400** of FIGS. **4**A and **4**B and include any of the components described above with respect to that embodiment. For example, as shown in FIG. **8**A, sensor cartridge **800** includes a case **860** coupled to a lid **880** having cutout **881** via hinge **878**. Sensor cartridge further includes a picker **825** and a rotating block **806**. To use sensor cartridge **800**, the user may open lid **880** by flipping it over hinge **878** to expose picker **825**. A biosensor **802** may be advanced using picker **825** and lid **880** may be closed. Rotating block **806** may be coupled to lid **880** such that closing lid **880** swivels rotating block **806** in the direction of arrow "R" and biosensor **802** is exposed through cutout **881** of lid **880**. Thus, biosensor **802** is reoriented to a second position, which may be easier for some users to grasp.

In FIGS. **9**A-C an embodiment having an automatic pass through is illustrated which includes a spring-loaded pusher. The lid **980** is pushed up as seen in FIG. **9**A and a ribbon **932** in the form of a spring pusher connects the lid **980** to a sled **925**. Closing of the lid **980** causes the spring pusher to advance a biosensor **902** through the front of the device. This concept is similar to that shown in FIGS. **7**A-C, except that the biosensor **902** is being passed to the front of the device **900** opposite the hinge **932** and the biosensor **902** is being deployed when the lid **980** is closed.

FIGS. **10**A-C illustrate a pass through and reorient embodiment similar to that shown in FIGS. **8**A-C. In this embodiment, sensor cartridge **1000** includes a hinged lid **1080** that opens as shown in FIG. **10**B. When the lid **1080** is being closed, a picker (not shown) advances a biosensor **1002** and reorients the biosensor **1002** using a rotating block (also not shown) so that it is advanced toward the user. Thus, using the rotating blocks described above, a biosensor may be reoriented and passed to the user at various angles and from various sides of the sensor cartridge **1000**. In addition to the embodiments, described several features may be added to any of the sensor cartridges or meters described to facilitate usage and increase reliability of the product. For example, in using a sensor cartridge or meter, a failure may occur when a slider or picker is partially cycled. Specifically, the user may advance a slider to engage a biosensor and advance it partially toward outside the device. If, however, the user stops the slider before completing the forward stroke and returns it to the home position, the slider may then engage a second biosensor. In some embodiments, the device may be configured to deliver a single biosensor at a time. Thus, when two biosensors attempt to exit the cartridge slot simultaneously, the slider may become jammed from moving forward. Returning the slider to the home position may exacerbate the problem by engaging additional biosensors.

Additionally, a single "dog-earred," bent, frayed or damaged biosensor may jam within the cartridge slot. Once a single bios sensor becomes jammed in a slot, others biosensors may become jammed as well. To address jamming of the biosensors, several features are described below. These features may be combined or used in conjunction with any of the embodiments described above.

FIG. **11**A is a perspective view of a slider **1122** having a picker **1125** for engaging a biosensor and a pawl **1126**. Picker **1125** may be formed in any of the configurations shown above. Pawl **1126** may be formed of a laterally flexible ratchet material. The addition of a pawl **1126** on the underside of the slider **1122** (e.g., the same side as the picker), may alleviate the problem of jamming when used in conjunction with the can **1130** of FIG. **11**B. Can **1130** includes ratchet teeth **1132** that extend from a home position **1136** to an end position **1138**, upon which pawl **1126** may travel. Can **1130** further includes a smooth track **1134** that extends parallel to the ratchet teeth **1132**.

In use, pawl **1126** of slider **1122** may slide forward over ratchet teeth **1132** of can **1130**. Pawl **1126** and ratchet teeth **1132** may be configured such that the pawl **1126** can only travel over ratchet teeth **1132** in the forward direction and not in the reverse direction. Once pawl **1126** has travel forward over the ratchet teeth, it may be urged to drop down to smooth track **1134** original models show track **1132** tapering to urge the pawl to track **1134**, not sure if this is necessary at the end position in the direction of arrow "P". Pawl **1126** and, thus slider **1122**, may travel back over smooth track **1134** from end position **1138** to home position **1136**. In this manner, slider **1122** must complete a full stroke over ratchet teeth **1132** before returning to the home position, resulting in less jamming of the biosensors.

A variation of this embodiment is shown in FIGS. **11**C and **11**D. Similar to the above embodiment of FIGS. **11**A-B, this embodiment includes a slider **1122** having a picker **1125**. Instead of a pawl **1126** at the back end of the slider **1122**, the slider of FIG. **11**C includes a flexible tab stop **1127**. Tab stop **1127** is guided over ratchet teeth **1132** of can **1130**, shown in FIG. **11**D, which includes a pair of pockets **1142** at the home position **1136** and the end position **1138** instead of a smooth track. Pocket **1142** may form a clearance that is large enough to allow reversal of the orientation of flexible tab stop **1127**.

Tab stop **1127** may slide over ratchet teeth **1132** in a forward direction from home position **1136** to end position **1138** but may be incapable of moving the reverse direction. Once tab stop **1127** reaches pocket **1142** at the end position **1138**, it

may reverse orientation within pocket **1142** and travel back over ratchet teeth **1132**. Thus, in this manner, tab stop **1127** is reversible only within pockets **1142** and slider **1122** only switches directions of travel while intra-cycle (e.g., at the ends of the ratchet teeth **1132** at pockets **1142**). Thus, this variation also compelling slider **1122** to complete a full stroke over ratchet teeth **1132** before returning to the home position, resulting in less jamming of the biosensors.

FIG. **12**A is a schematic cross-sectional view of a replaceable cartridge similar to FIG. **3**B but having an anti-jamming feature. Sensor cartridge **100** may be loaded in a meter housing **200**. Meter housing **200** may include a taper fitting **204** that will contact sealing flange **106**. During loading a taper fitting **204** in the meter housing **200** engages sensor cartridge **100** and deforms it in such a way as to allow biosensors **102** to move freely. Sensor cartridge **100** may further include a deflecting portion **1202** attached at hinge **1204**. Deflecting portion **1202** may rotate about hinge **1204** in the direction of arrow "O" to open and provide access to the interior of sensor cartridge **100**. Thus, when a deformed biosensor or multiple biosensors **102** do not exit smoothly, the flexible deflecting portion **1202** may create a temporary allowance of more than on biosensor to clear the jam.

FIG. **12**B is a schematic side view of a replaceable cartridge **400** similar to that described in FIG. **4**B but having a feedback feature **1204**. Feedback feature **1204** may be in the form of depressions formed at positions beneath picker **425** and cap portion **410** and may provide a snapping sound or tactile feedback to the user about the location of picker **425**. Thus, the user may become aware that the picker **425** has reached the end of the forward stroke or backward stroke, reducing the risk of biosensor jamming. In addition to depressions, it will be understood that feedback feature **1204** may also include ribs, bumps, recesses, or any other feature capable of providing tactile feedback while allowing picker **425** to travel smoothly across the track as described in the above embodiments. It will be understood that replaceable cartridge **400** may include one, two, three, four or more feedback features **1204** and that the feedback features may include any of the combinations described above.

In addition to these features, the lid of the device may further be modified to prevent jamming and partially excised biosensors. Specifically, if a slider or picker does not complete a full forward stroke, a partially excised biosensor may remain in the cartridge. Jammed or partially excised biosensors may allow humidity into the device, thereby damaging the biosensors.

FIGS. **13**A and **13**B are schematic cross-sectional views of a lid **1380** according to one embodiment of the present invention. As seen in these figures, lid **1380** may include a ridge **1382** along the length of the lid, and having a small cavity **1384** for accepting a picker. Ridge **1382** prevents lid **1380** from closing on the sensor cartridge unless the picker is returned to an end (e.g., home position) within cavity **1384**. Thus ridge **1382** may disallow closure of a lid **1380** until the picker is returned to the home position. This feature may be used alone or in combination with any of the features disclosed above.

A disposal area for used biosensors may also be incorporated into any of the embodiments shown above. FIGS. **14**A and **14**B are back end and schematic cross-sectional views of one such cartridge. Replaceable cartridge **1400** includes a disposal compartment **1484** in a lid **1480**. Disposal compartment **1484** may be in communication with ambient air via disposal slot **1482** in the back of the sensor cartridge **1400**. Lid **1480** may be capable of opening over hinge **1478** to expose a picker or slider as described above. The user may close lid **1480** after using the biosensor and dispose of the contaminated biosensor through disposal slot **1482** into disposal compartment **1484**. Disposal compartment **1484** may be sealed off from any of the other components of the device. Additionally, disposal slot **1482** may include a closing flap **1486** to prevent contaminated biosensors from falling out of the disposal compartment. When the disposal compartment **1484** is full or the device is out of biosensors, the user may dispose of the entire device with the contaminated biosensors.

In addition to ratchet teeth, and lids with ridges, features may be added to automatically retract a picker to the home position. FIGS. **15**A-C are schematic illustrations of a replaceable cartridge **1500** having a retraction spring **1510** coupled to picker **1525**. Retraction spring **1510** may include a constant force spring **1525** to urge picker **1525** to the home position. Thus, a user may actuate picker **1525** to engage a biosensor and push the picker against the spring force. Once the user releases the picker **1525**, retraction spring **1510** may force picker **1525** to return to the home position. In this way, the likelihood of engaging multiple strips may be decreased.

Although the invention herein has been described with reference to particular embodiments, it is to be understood that these embodiments are merely illustrative of the principles and applications of the present invention. It is therefore to be understood that numerous modifications may be made to the illustrative embodiments and that other arrangements may be devised without departing from the spirit and scope of the present invention as defined by the appended claims.

It will be appreciated that the various dependent claims and the features set forth therein can be combined in different ways than presented in the initial claims. It will also be appreciated that the features described in connection with individual embodiments may be shared with others of the described embodiments.

The invention claimed is:

1. A replaceable sensor cartridge comprising:

a frame having a desiccant material capable of reducing humidity within the frame and configured to house a plurality of biosensors;

a strip picker configured and arranged to slide along a top portion of the frame in a forward stroke to deploy a top biosensor from the plurality of biosensors and a reverse stroke to its home position, the strip picker including a flexible pawl for providing a ratchet action along the top portion of the frame; and

at least one anti-jamming feature feature including a deflecting portion on the replaceable sensor cartridge.

2. The replaceable sensor cartridge of claim **1**, wherein the frame includes a plurality of ratchet teeth and a parallel smooth track, the frame being configured to mate with the pawl of the strip picker and allow the forward stroke along the ratchet teeth and the reverse stroke along the smooth surface.

3. The replaceable sensor cartridge of claim **1**, further including a lid for covering the top portion of the frame, the lid having a longitudinally extending ridge and a cavity for accepting the strip picker.

4. The replaceable sensor cartridge of claim **3**, wherein the lid defines a disposal compartment for accepting contaminated biosensors and a disposal slot for inserting the contaminated biosensors into the disposal compartment.

5. A replaceable sensor cartridge comprising:

a frame having a desiccant material capable of reducing humidity within the frame and configured to house a plurality of biosensors;

a strip picker configured and arranged to slide along a top portion of the frame in a forward stroke to deploy a top biosensor from the plurality of biosensors and a reverse

stroke to its home position, the strip picker including a flexible pawl for providing a ratchet action along the top portion of the frame;

a lid for covering the top portion of the frame, the lid having a longitudinally extending ridge and a cavity for accepting the strip picker, the lid configured to close only when the strip picker is at an end of the frame; and

at least one anti-jamming feature.

6. The replaceable sensor cartridge of claim **5**, wherein the anti-jamming feature includes a retraction spring coupled to the strip picker and configured to return the strip picker to the home position.

7. The replaceable sensor cartridge of claim **6**, wherein the retraction spring is a constant force spring.

8. The replaceable sensor cartridge of claim **5**, wherein the lid defines a disposal compartment for accepting contaminated biosensors and a disposal slot for inserting the contaminated biosensors into the disposal compartment.

9. The replaceable sensor cartridge of claim **5**, wherein the frame includes a plurality of ratchet teeth and a parallel smooth track, the frame being configured to mate with the pawl of the strip picker and allow the forward stroke along the ratchet teeth and the reverse stroke along the smooth surface.

10. The replaceable sensor cartridge of claim **5**, wherein the anti-jamming feature includes at least one feedback feature.

11. The replaceable sensor cartridge of claim **10**, wherein the at least one feedback feature is configured to provide a tactile feedback when the strip picker is at an end of the forward or reverse stroke.

12. The replaceable sensor cartridge of claim **10**, wherein the at least one feedback feature includes a depression disposed on the frame.

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